Programming DBS: Trouble Shooting Strategies

Susan Heath, M.S., R.N.
Movement Disorders Clinical Nurse Specialist
Associate Director of Clinical Care
San Francisco VA
Parkinson's Disease Research and Clinical Center (PADRECC)

Parkinson's Disease Research, Education & Clinical Center
San Francisco VA PADRECC

Common Problems Encountered in DBS Therapy

Lead location → suboptimal placement?

Programming suboptimal?

Device-related issues or malfunction?

Has there been an over zealous medication reduction?
(pt under-medicated?) Or unrealistic expectations?

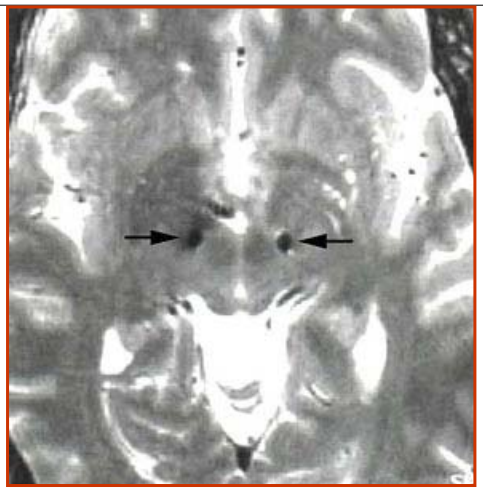
Is it a Lead Location Problem?

- What does the post-op MRI show?
- 1.5 tesla magnet only

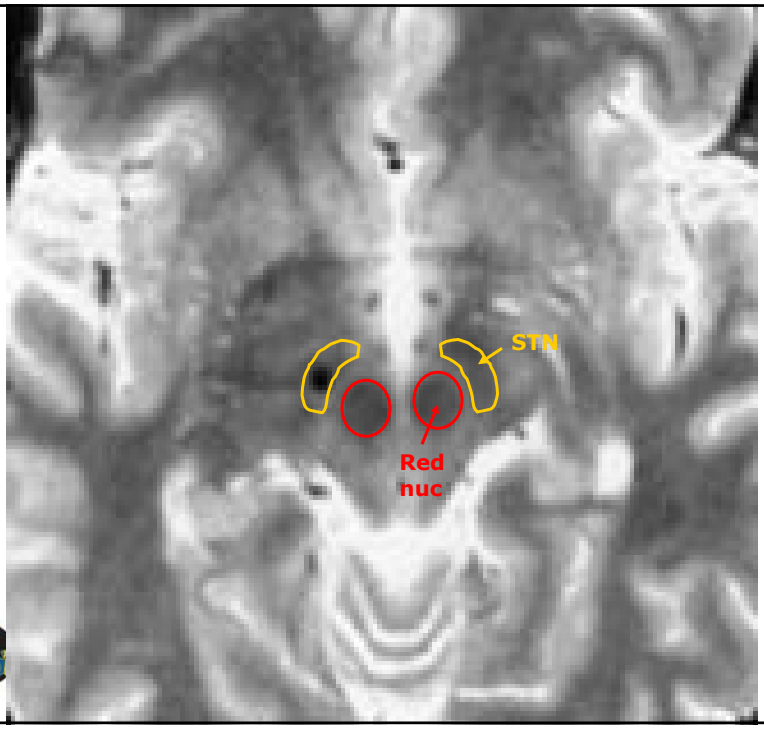
Paul S. Larson, R. Mark Richardson, Philip A. Starr, Alastair J. Martin (2008). **Magnetic Resonance Imaging of Implanted Deep Brain Stimulators: Experience in a Large Series.** Stereotactic Functional Neurosurgery; 86:92–100

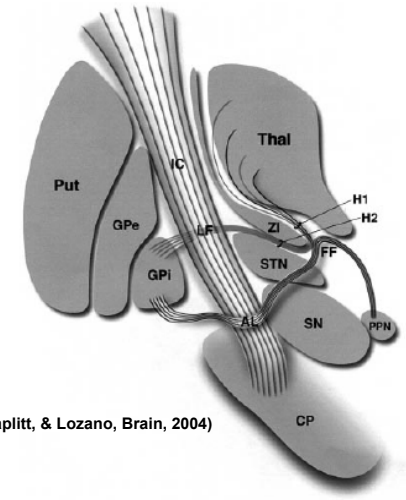
National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Post-Operative MRI



National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy



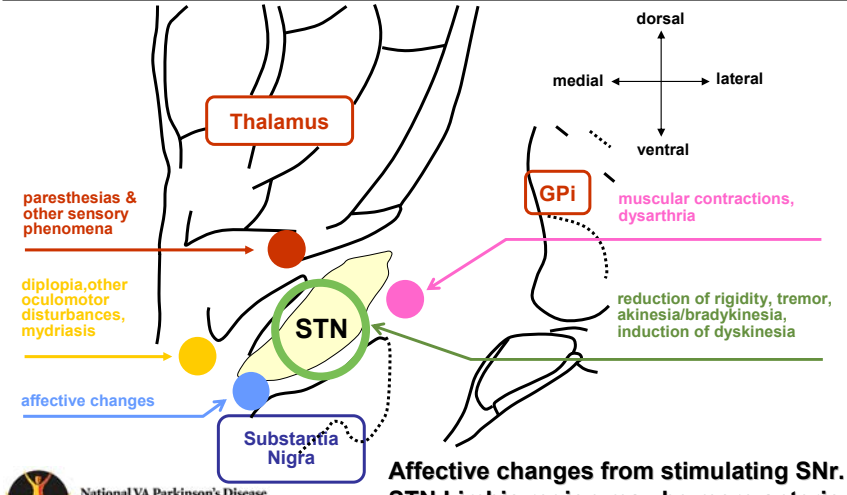


(Hamani , Saint-Cyr, Fraser, Kaplitt, & Lozano, Brain, 2004)

Fig. 1 Representation of the major anatomical structures and fibre tracts associated with the subthalamic nucleus. AL = ansa lenticularis; CP = cerebral peduncle; FF = Fields of Forel; GPe = globus pallidus externus; GPi = globus pallidus internus; H1 = H1 Field of Forel (thalamic fasciculus); IC = internal capsule; LF = lenticular fasciculus (H2); PPN = pedunculopontine nucleus; Put = putamen; SN = substantia nigra; STN = subthalamic nucleus; Thal = thalamus; ZI = zona incerta.

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

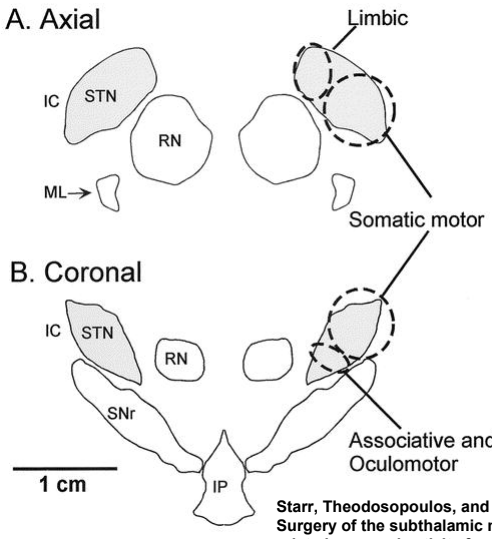
Lead Location Directly Influences Programming: STN



National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Affective changes from stimulating SNr. STN Limbic region may be more anterior to motor region.

FIGURE 2



Starr, Theodosopoulos, and Turner. Surgery of the subthalamic nucleus: use of movement-related neuronal activity for surgical navigation. Neurosurgery. 2003 Nov;53(5):1146-9; discussion 1149

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

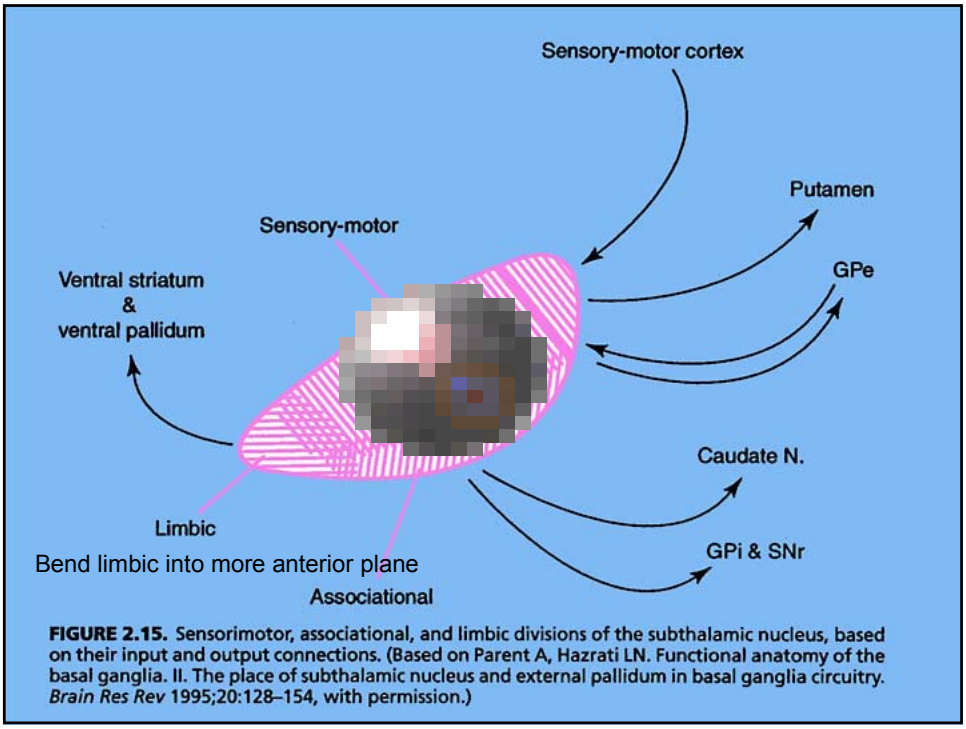


FIGURE 2.15. Sensorimotor, associational, and limbic divisions of the subthalamic nucleus, based on their input and output connections. (Based on Parent A, Hazrati LN. Functional anatomy of the basal ganglia. II. The place of subthalamic nucleus and external pallidum in basal ganglia circuitry. *Brain Res Rev* 1995;20:128–154, with permission.)

Common Problems Encountered in DBS Therapy

Lead location → suboptimal placement?

Programming suboptimal?

Device-related issues or malfunction?

Has there been an over zealous medication reduction? (pt under-medicated?) Or unrealistic expectations?

Programming with Gusto

- Has each contact been screened using *maximum tolerated voltage* to assess ceiling threshold?
  - Determines therapeutic window
  - Titrate just below maximum tolerated voltage
- Kinetra batteries require higher voltages

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Three Dimensional STN Anatomy

- Medial and posterior = leminscal fibers
- Lateral and anterior = capsular fibers
- Anterior to motor = limbic pathways ?
- Deep and medial = SNr = limbic
- Medial and deep = IIIrd nerve
- Lateral to STN, genu of capsule = congugate gaze eye signs

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

STN Side Effects at Low Thresholds

Expected side effects from lead location*:*

- Persistent Paresthesias → Too posterior or medial (Lemniscal fibers)
- Dysarthria, pulling/contractions →Too lateral (Capsule)
- Diplopia → Too deep, a**nteromedial**
- Dyskinesias → In optimal location
- Mood changes → Too anterior and medial
- **No effect at high voltages →** Too superior or anterior

Common Problems Encountered in DBS Therapy

Lead location → suboptimal placement?

Programming suboptimal?

Device-related issues or malfunction?

Has there been an over zealous medication reduction?
(pt under-medicated?)

Is Problem a Device Malfunction?

- Impedance checks – verify electrical integrity
- Kinetra (use 4.0V or 4.5V to run checks)
- Soletra (use std 1.5V to run checks)
- Short circuit = two contacts or wires connecting → rapid battery depletion
- Open Circuit = loss of one or more contacts with sudden loss of efficacy

Impedance Readings

– Impedance & current drain indicate status of system (applies to Soletra)

- *Normal*: impedance 600-1300 Ω; current drain <12-30 μA

- *Open Circuit*:
- Soletra impedance >2000 Ω; current drain <7-9 μA
- Kinetra impedance>4000 Ω; current drain <7-9 μA

- *Short Circuit*: impedance <250 Ω; current drain >500 μA

Open Circuit – loss of one or more contacts

Electrode Impedances
(1.5 V, 210 μs, 30 Hz)

Electrode Pair	Impedance (Ω)	Current (μA)
0 & c	>2000	<7
1 & c	>2000	<7
2 & c	>2000	<7
3 & c	>2000	<7
0 & 1	1137	14
0 & 2	1480	12
0 & 3	1535	12
1 & 2	1159	14
1 & 3	1381	13
2 & 3	1217	13

Wire Bond failure = Loss of unipolar, but preserved bipolar function.

This pt had loss of efficacy in Monopolar setting, but, preserved function in bipolar setting

Lead Fracture – Open Circuit

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Short Circuit

- Short Circuit: Two wires making contact
- Impedance <250 Ω; current drain >500 μA
- Rapid depletion of battery life

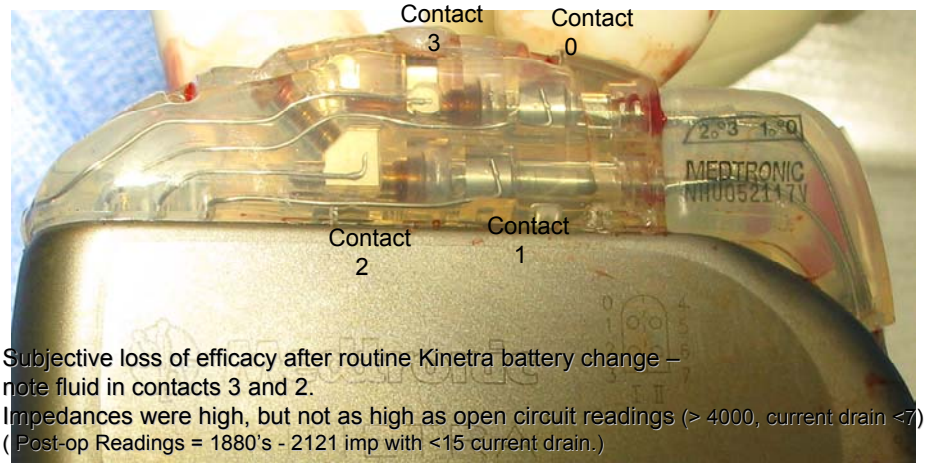
National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Kinetra Impedance Challenges

- Less reliable and harder to interpret
- Run 900's -1800's (wider range, and sometimes higher than Soletra)
- Often similar readings between many contacts/settings – unclear how to interpret

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Kinetra Battery with 'fluid in the boot'



Subjective loss of efficacy after routine Kinetra battery change – note fluid in contacts 3 and 2.
Impedances were high, but not as high as open circuit readings (> 4000, current drain <7)
(Post-op Readings = 1880's - 2121 imp with <15 current drain.)

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Low Battery Issues

- **Soletra** low battery = **< 3.60V**, common for pts to want 'more juice' or feel less well
- **Kinetra** low battery = **< 2.40V**, uncommon for pts to feel loss of efficacy (start surgical referral at 2.50V)
- Advanced PD patients have required inpatient admission due to severe PD sx's after battery failed
- Goal is to monitor battery and replace *before* battery fails
- Need 2-4 weeks to plan replacement surgery

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy

Common Problems Encountered in DBS Therapy

Lead location → suboptimal placement?

Programming suboptimal?

Volts pushed up to just below side effects?
At high voltages, what are the side effects?

Device-related issues or malfunction?

- Hardware issues: wire fracture or crushed?
- Factory recall :'wire bond' disruption in battery

Has there been an over zealous medication reduction? (pt under-medicated?)

Patient Education: Identify Secret Unrealistic Expectation(s)

- Managing Pt expectations "mantra"
  - DBS is not a cure for PD, can't find 'holy grail' settings
  - Optimal results from stimulation different for each patient
- DBS settings and medications often need to be adjusted concurrently with STN (goes against rule to change one variable at a time)

Adjunctive therapies needed for advanced pts: physical therapy, occupational therapy and speech therapy often indicated

- Depression common after medication reduction

National VA Parkinson's Disease CONSORTIUM
Education • Collaboration • Advocacy